Probing femtosecond dynamics of laser-produced plasmas

Tiago Pinto, Randy Meijer, Aneta Stodolna, Stefan Witte, Kjeld Eikema

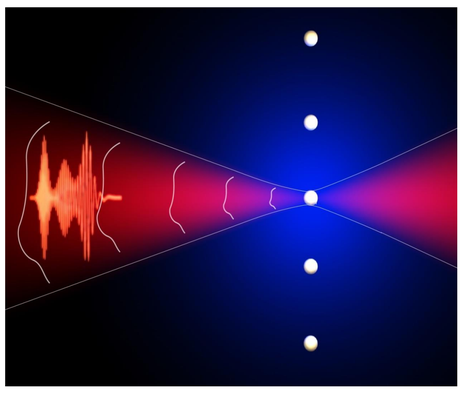
ARCNL, Science Park 110, 1098 XG Amsterdam, The Netherlands

ARCNL
ADVANCED RESEARCH CENTER FOR NANOLITHOGRAPHY
ARCNL is a public-private partnership between FOM, UvA, VU and ASML

Abstract

We present our progress on the development of a high-energy YAG-based picosecond laser-amplifier to serve as a pump for a femtosecond OPCPA in the near and mid-IR. In addition, we present a Nd:YAG-based system delivering up to 400 mJ pulses with 0.5-1000 ns pulse duration and full control over the temporal pulse shape. These systems independently, and together in pump-probe configurations, are powerful tools in understanding EUV production by LPPs.

Motivation: EUV generation in Tin droplets

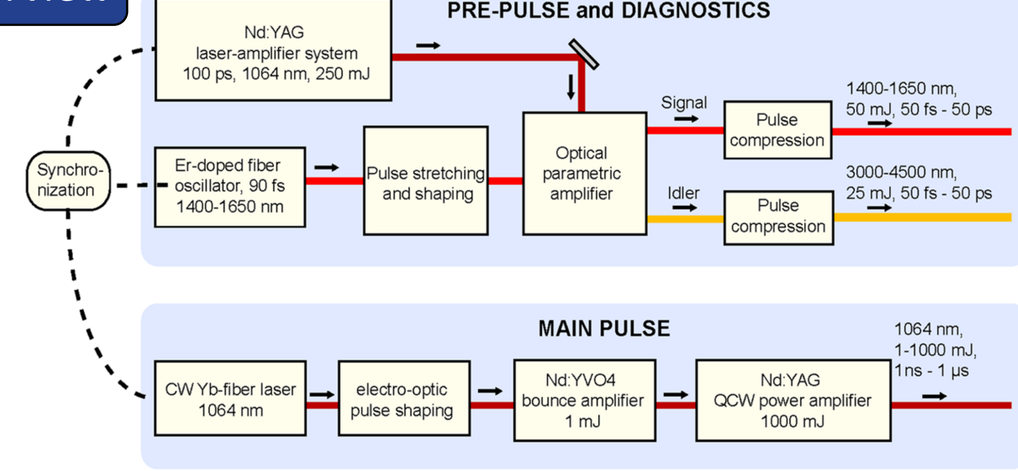


Our focus is to study the laser-plasma interaction dynamics, while aiming to increase the efficiency of EUV emission of Tin LPPs.

Key points of study include:

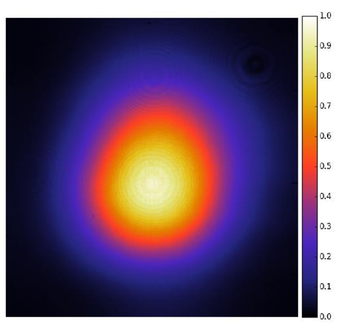
- **Plasma formation**
- **Droplet shaping**
- **Ion velocity distributions**
- **Debris generation**

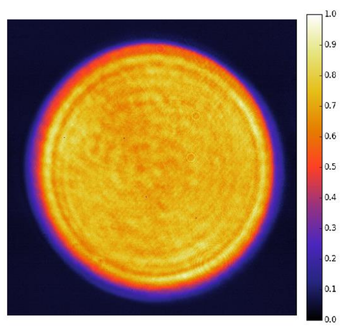
Setup overview



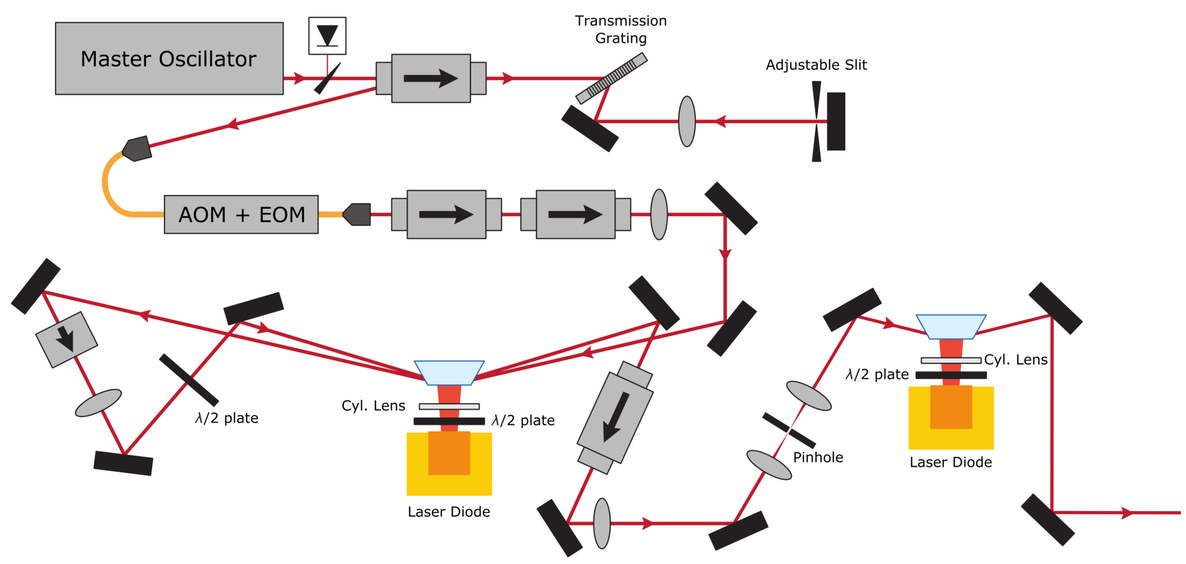
Output from ps

- **50 – 150 ps durations**
- **Smooth Gaussian up to 1 mJ from the bounce amplifier**
- **High quality flat-top output up to 220 mJ using a double YAG rod configuration**
- **Excellent pulse-to-ASE contrast without complex filtering solutions**

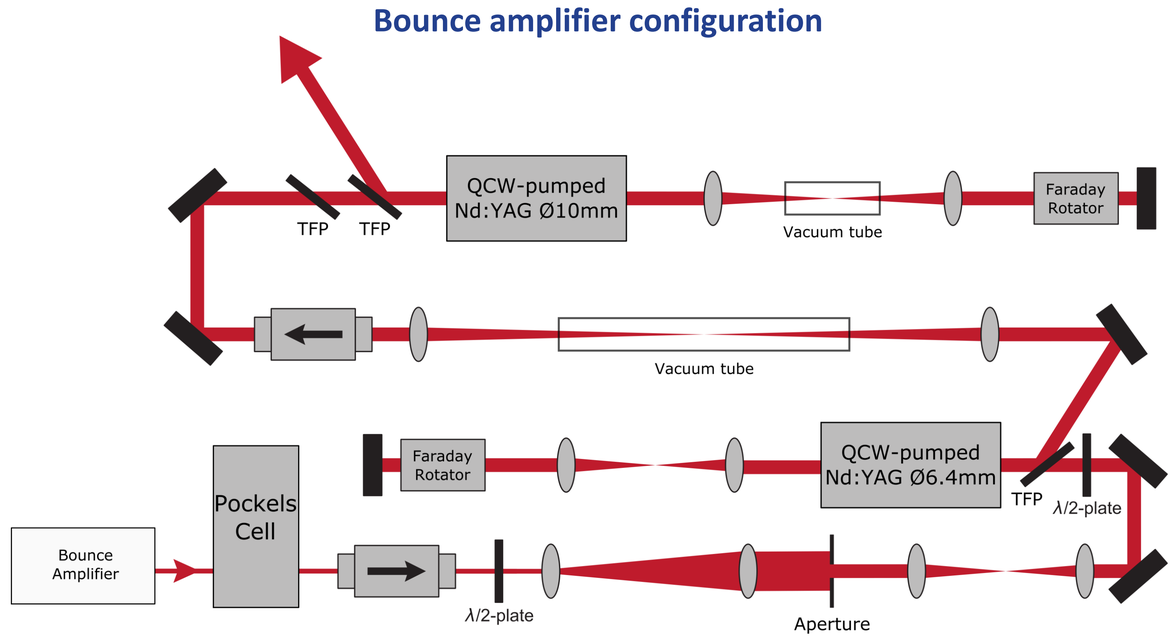




Amplifier geometries



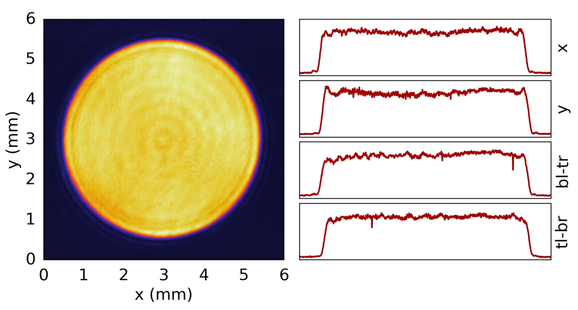
Bounce amplifier configuration

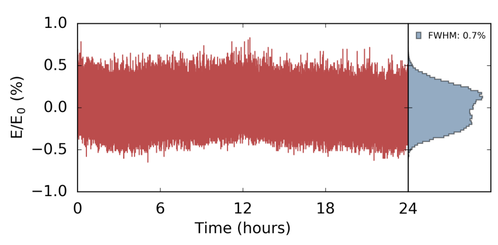


YAG rod amplifier configuration

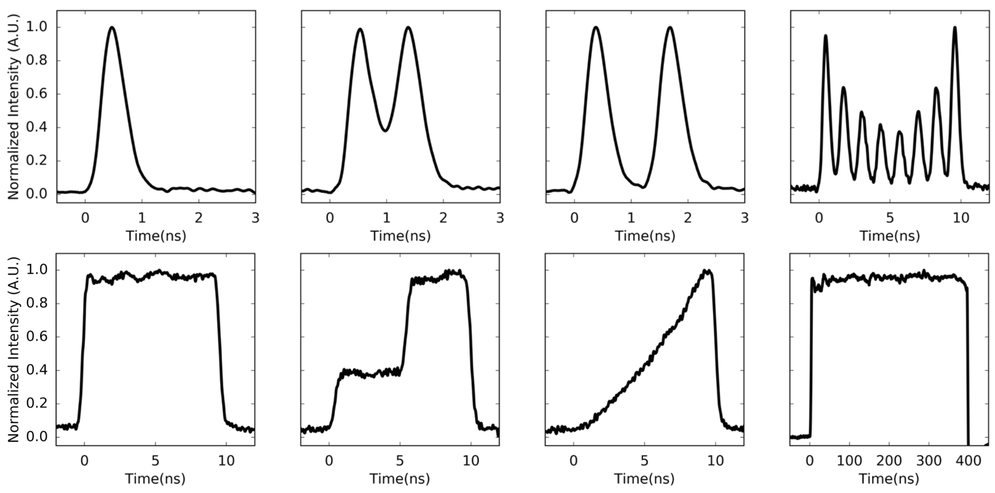
Ns output

- **0.5 – 1000 ns durations**
- **250 – 400 mJ pulse energy using a single YAG rod configuration**
- **Excellent flat-top profile**
- **Near arbitrary temporal pulse shapes, with sub-ns resolution (see below)**
- **0.7% power fluctuation over a 24h period**



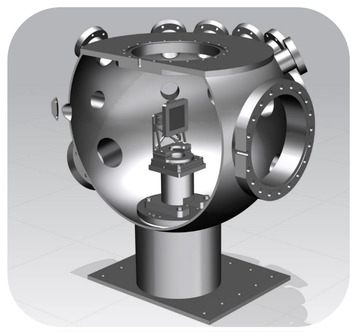


Advanced pulse shaping



Outlook and planned experiments

- **fs OPCPA currently under development**
- **Progressing to 1 J in the ns system**
- **Currently preparing solid target experiments**
- **Preparing collaboration experiments using Sn droplet targets**



Contact

Tiago Pinto, PhD Student,
Advanced Research Center for Nanolithography,
t.fariapinto@arcnl.nl, Tel.: +31-20-851 7167